Dr. Surin Worakijthamrong

Position & Experience:

- 21 years Experience on Water Management field
- *Director of Groundwater Development group*, Department of Groundwater Resources, Ministry of Natural Resources and Environment
- *Project Manager,* 'Groundwater Development projects in rural areas such as Groundwater development for Agriculture, Groundwater Development for School'
- *Co-instructor* with USGS on Applied Groundwater Modelling
- *Lecturer* on Water Resources Management

Question 1

"If No rainfall is occurred for a year and farmer still need to grow their products

No water in the river, only groundwater

How much the water can we pump out in this area without effect"

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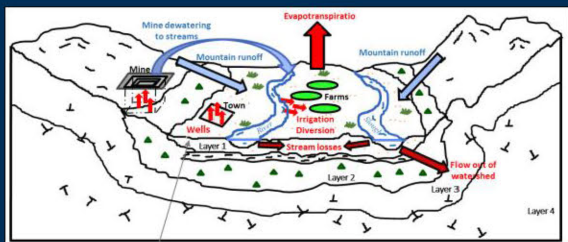
Question 2

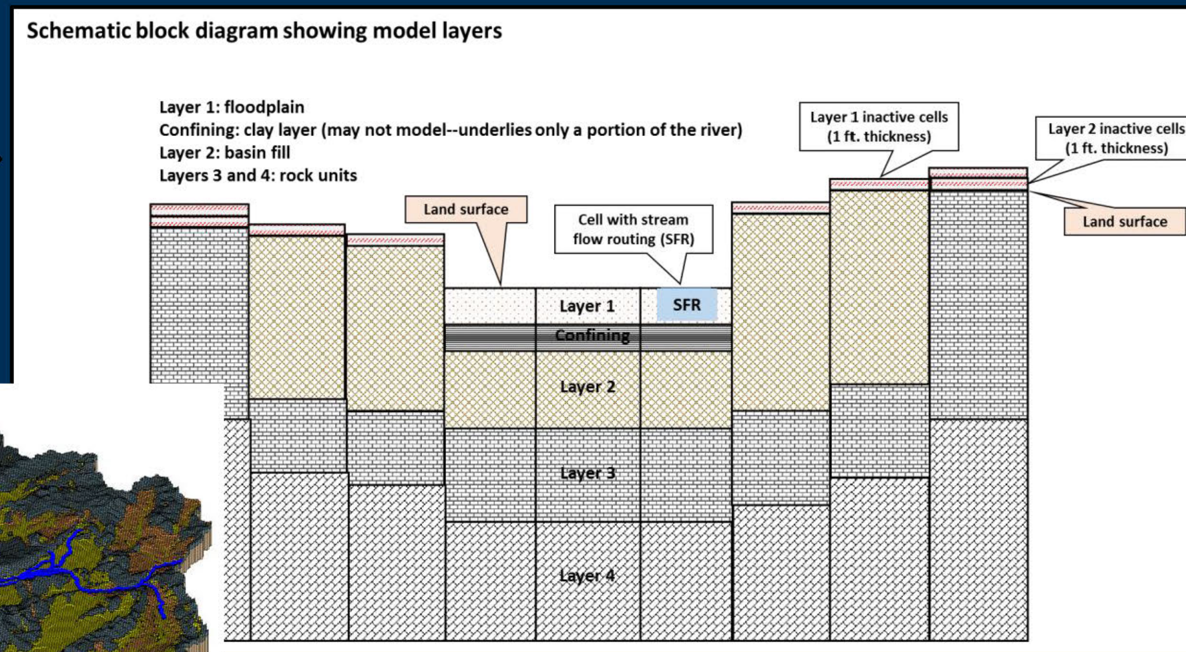
“If we need to speed up our GDP by increasing agricultural products in this area, How much water we can pump without causing Land subsidence”

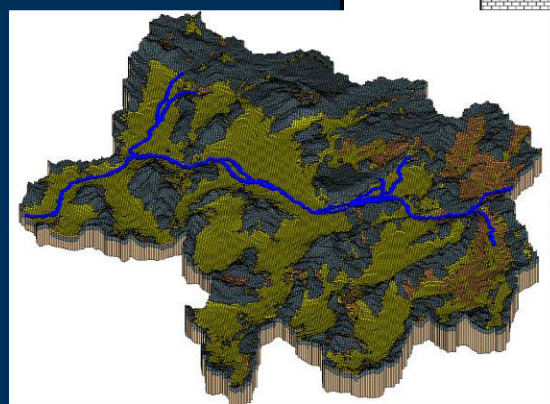
Question 3

"If There is mining rig on the upstream, whether it can affect the farm land downstream. If so, how fast it is and what is the magnitude"

Why MODFLOW







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Answer + Solve + make decision on

Complex natural and environmental issues

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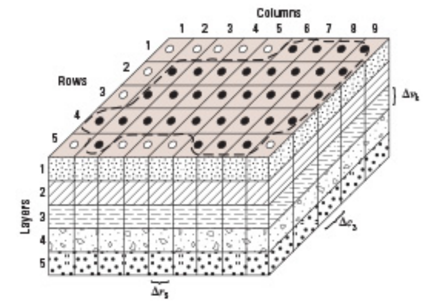
MODFLOW

- 3D Groundwater Flow Model

  (Flow, Transport, Management, Rainfall runoff)



- Developed by U.S. Geological Survey

- Widely use > 30 years

MODFLOW-84	MODFLOW-88	MODFLOW-96	MODFLOW-2000	MODFLOW-2005	MODFLOW-6
Year 1984	Year 1988	Year 1996	Year 2000	Year 2005	Year 2017

100% FREE

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MODFLOW

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New & Noteworthy

- NEW USGS Groundwater Monthly Highlights

Featured Science

- NEW MODFLOW 6: USGS Modular Hydrologic Model
- Using Data to Build a Sustainable Water Future
- USGS Groundwater Monitoring Well Redevelopment Using Air Lift Method [VIDEO]

Press Releases

- USGS Releases New JavaScript Library to Create Location Search Widgets for Web Applications
- New App Shows Aquifer Level Change and Subsidence in Relation to Groundwater Withdrawals in Houston-Galveston Area

USGS in Your State

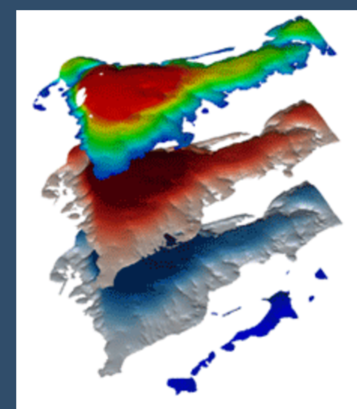
USGS Water Science Centers are located in each state

Water Software > Groundwater Software > MODFLOW and Related Programs

MODFLOW and Related Programs

MODFLOW is the USGS's modular hydrologic model. MODFLOW is considered an international standard for simulating and predicting groundwater conditions and groundwater/surface-water interactions.

Originally developed and released solely as a groundwater-flow simulation code when first published in 1984, MODFLOW's modular structure has provided a robust framework for integration of additional simulation capabilities that build on and enhance its original scope. The family of MODFLOW-related programs now includes capabilities to simulate coupled groundwater/surface-water systems, solute transport, variable-density flow (including saltwater), aquifer-system compaction and land subsidence, parameter estimation, and groundwater management.



Current MODFLOW Core Version: MODFLOW 6

A new object-oriented program and underlying framework called MODFLOW 6 was developed to provide a platform for supporting multiple models and multiple types of models within the same simulation. This version

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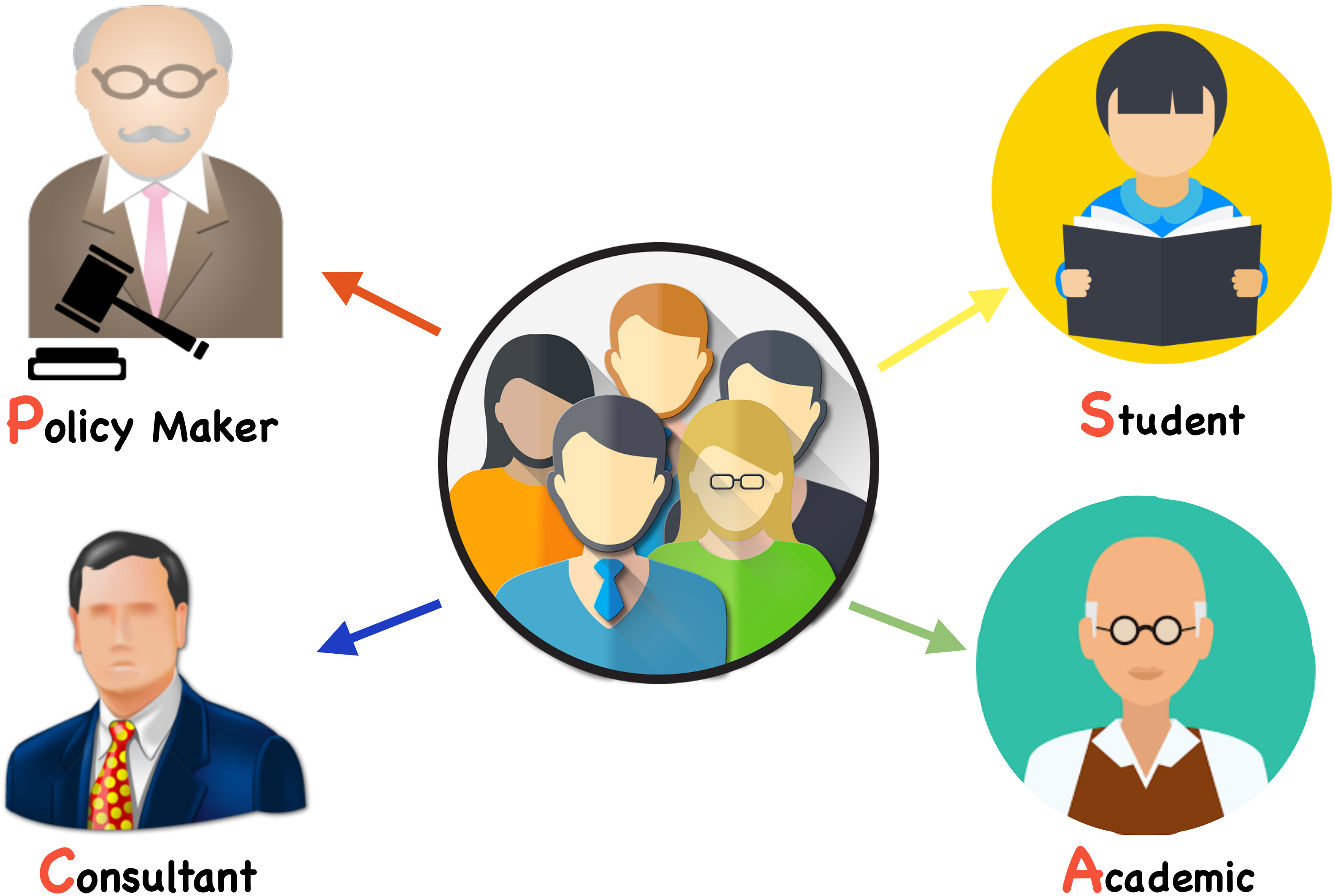

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Question 1

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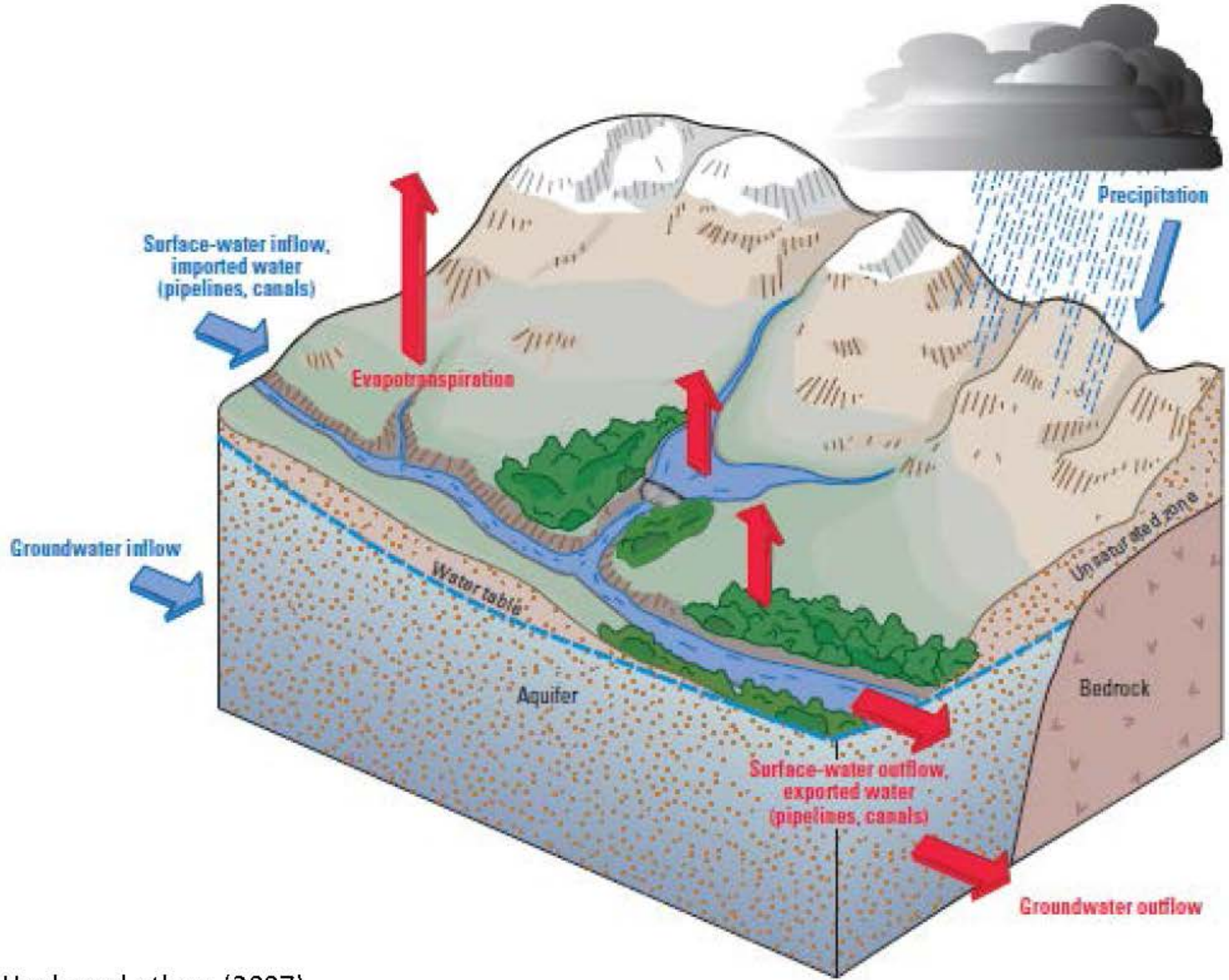
How much the water can we pump out in this area without effect”

Account for water with a "budget"



Healy and others (2007)

Water budgets: a unifying theme for assessment of groundwater availability

Understanding water budget components can be used to aid management of resource

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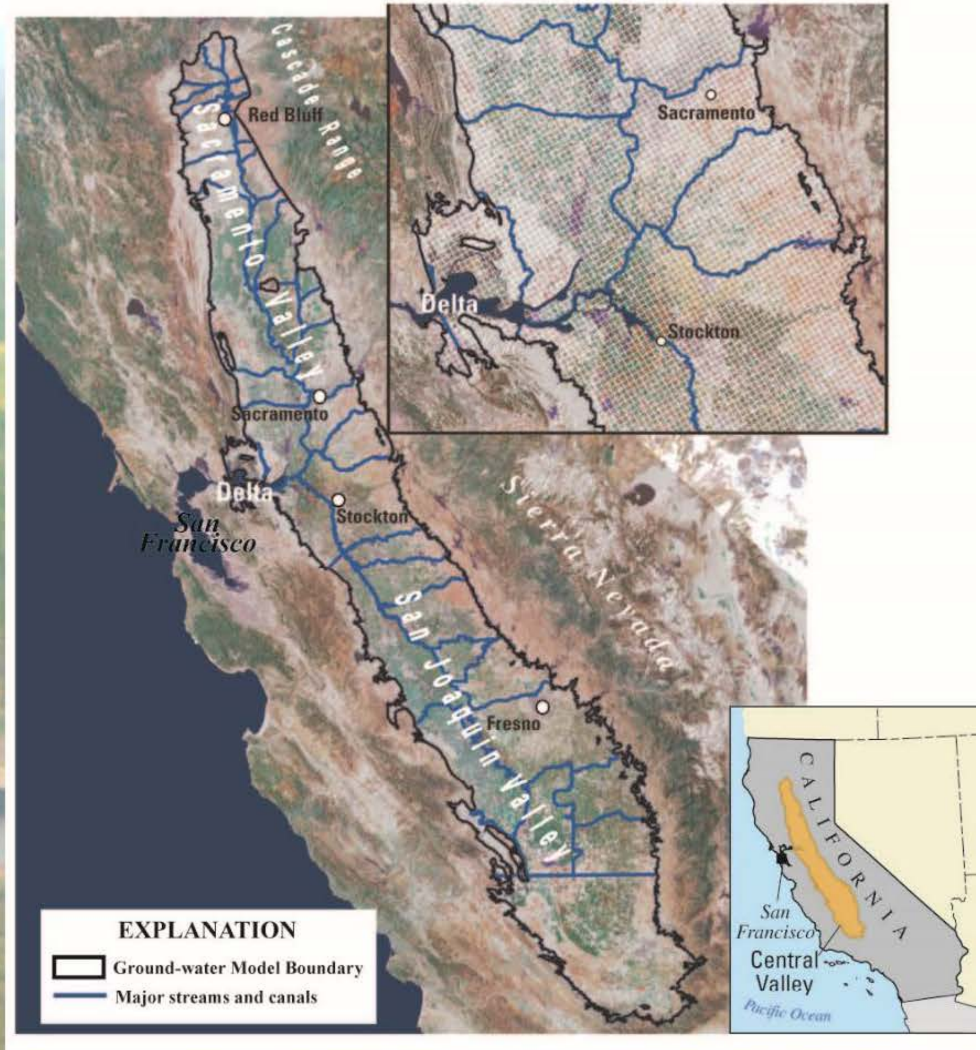
California's Central Valley

- 20,000 square miles
- Using about 1% of U.S. farmland, California's Central Valley
  - -Produces more than 250 different crops
  - -Supplies 7% of the U.S. agricultural output (by value) — including about half of the Nation's fruits, nuts, and vegetables
- Approximately 10-20% of the Nation's groundwater is pumped from the Central Valley aquifer system every year.



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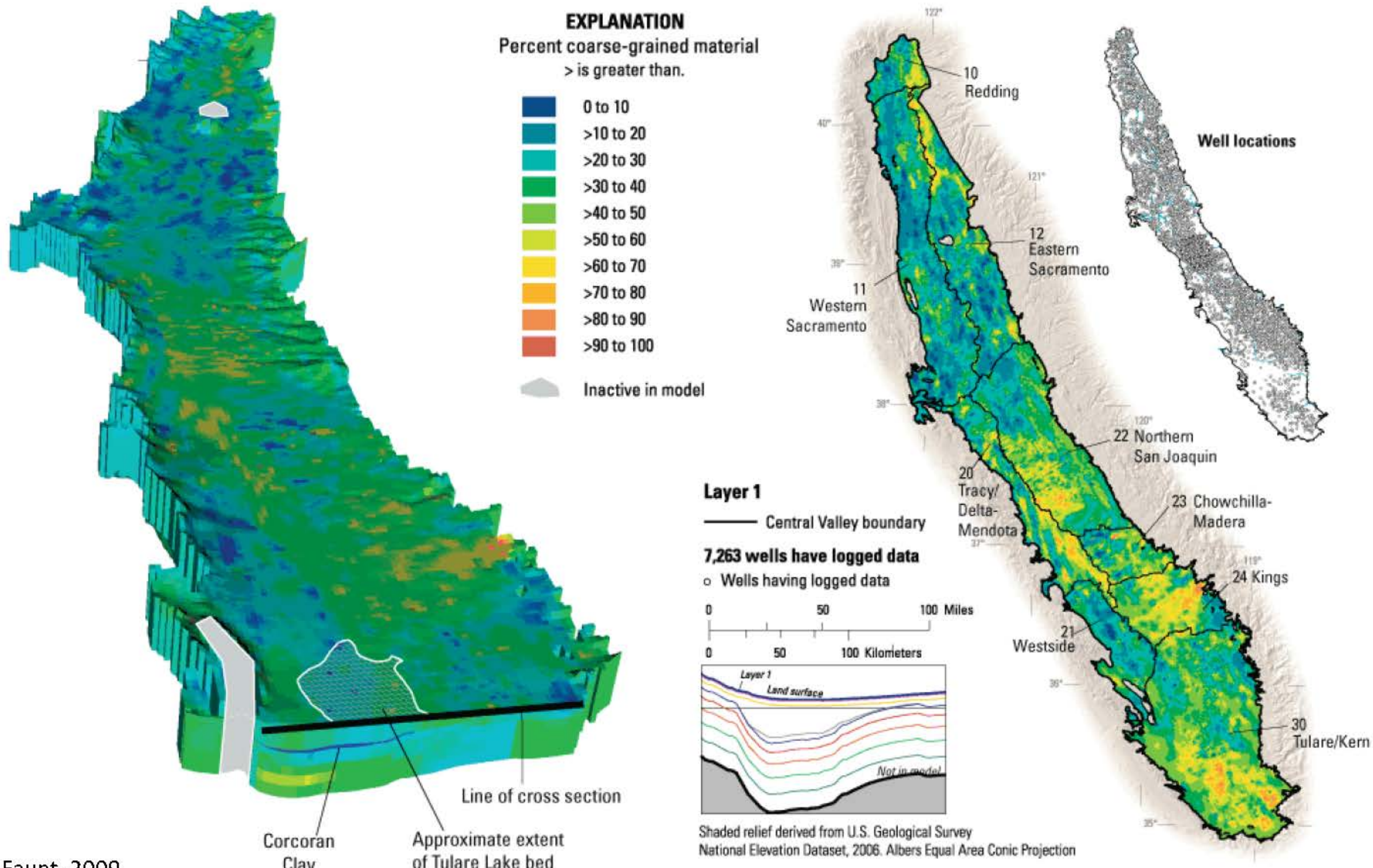
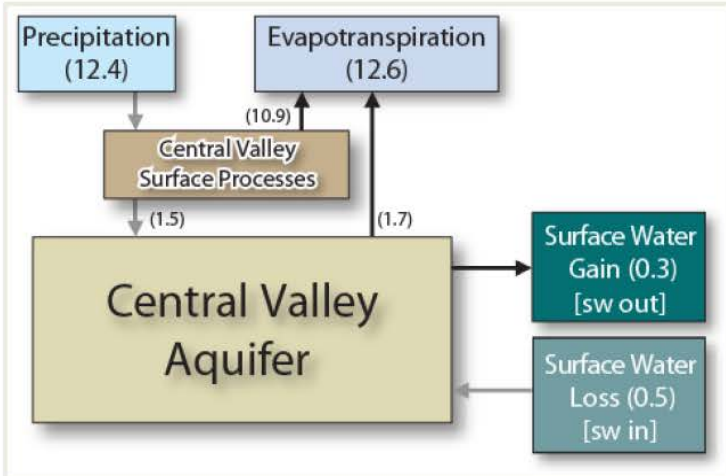
Define 3-D Hydrogeologic Framework



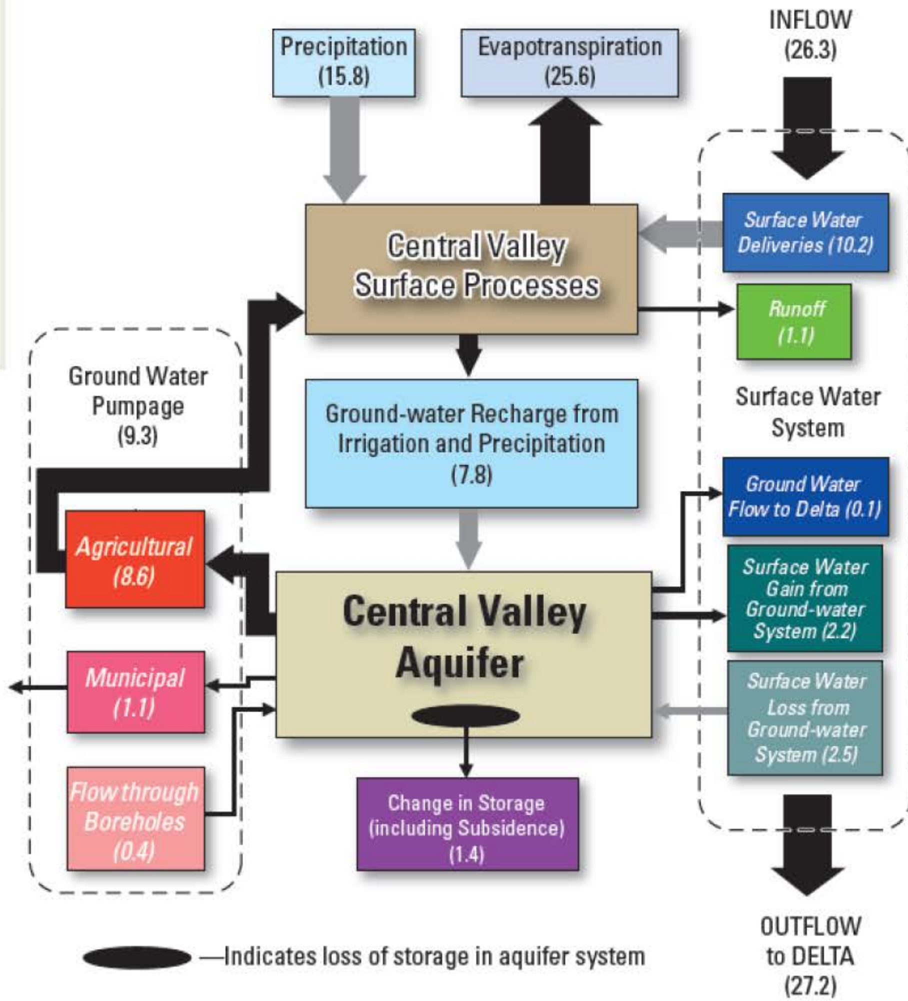
Faunt, 2009

Regional Water Budget



Natural	→	**Engineered**
Simple	→	**Complex**
2 million acre-feet/year recharge /discharge	→	**12 million** acre-feet/year recharge /discharge

Post-development



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Question 2

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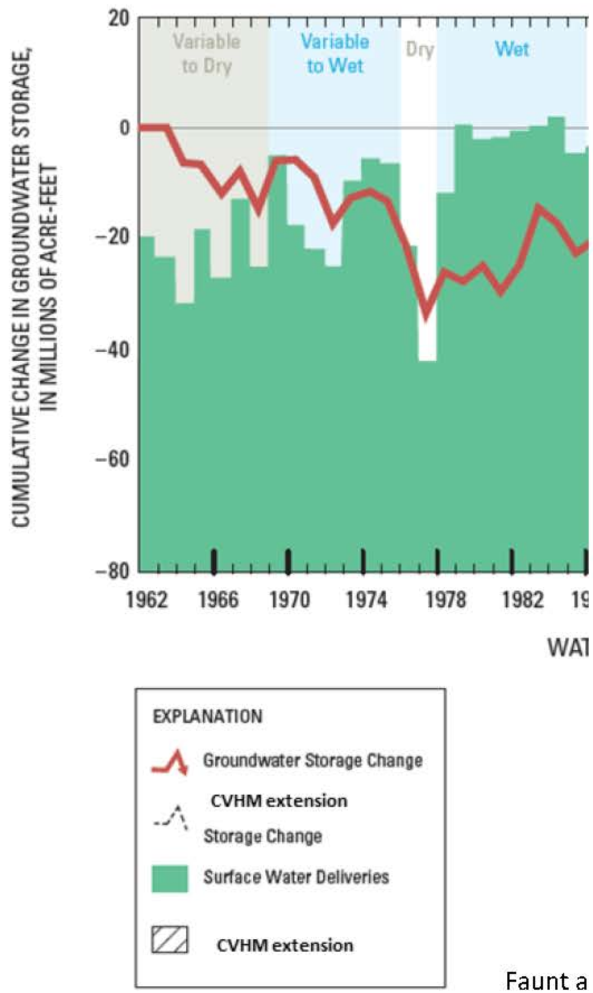
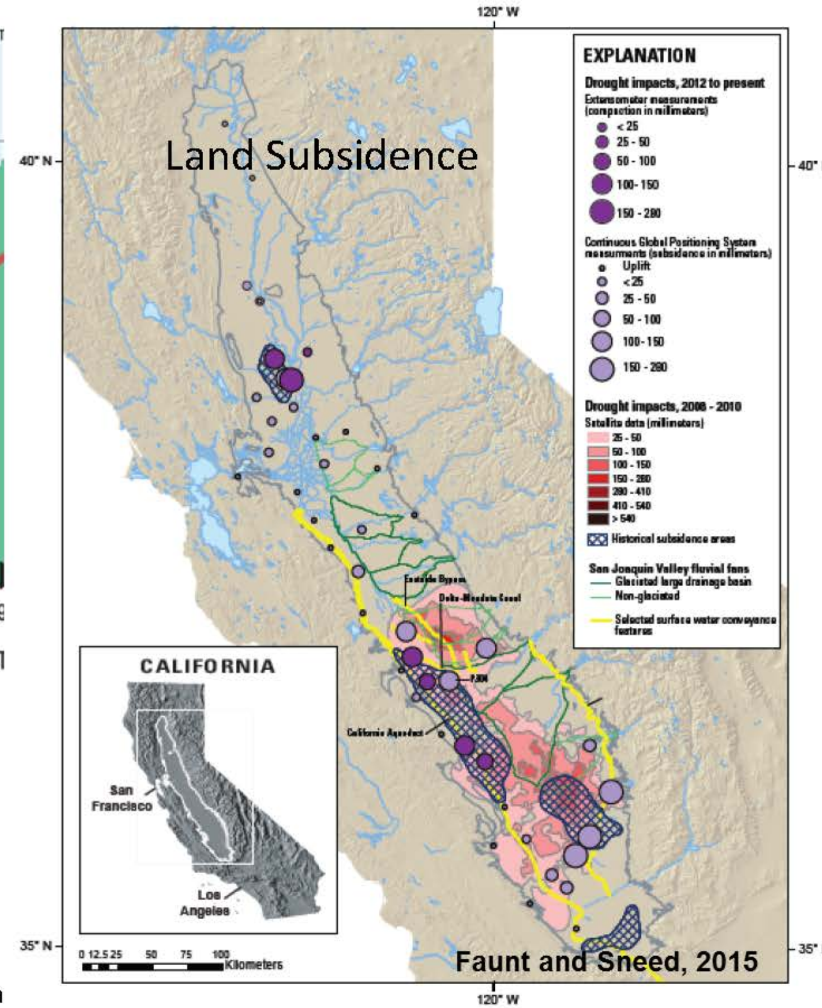
Modeling Used to Forecast System Response





Faunt a

Question 3

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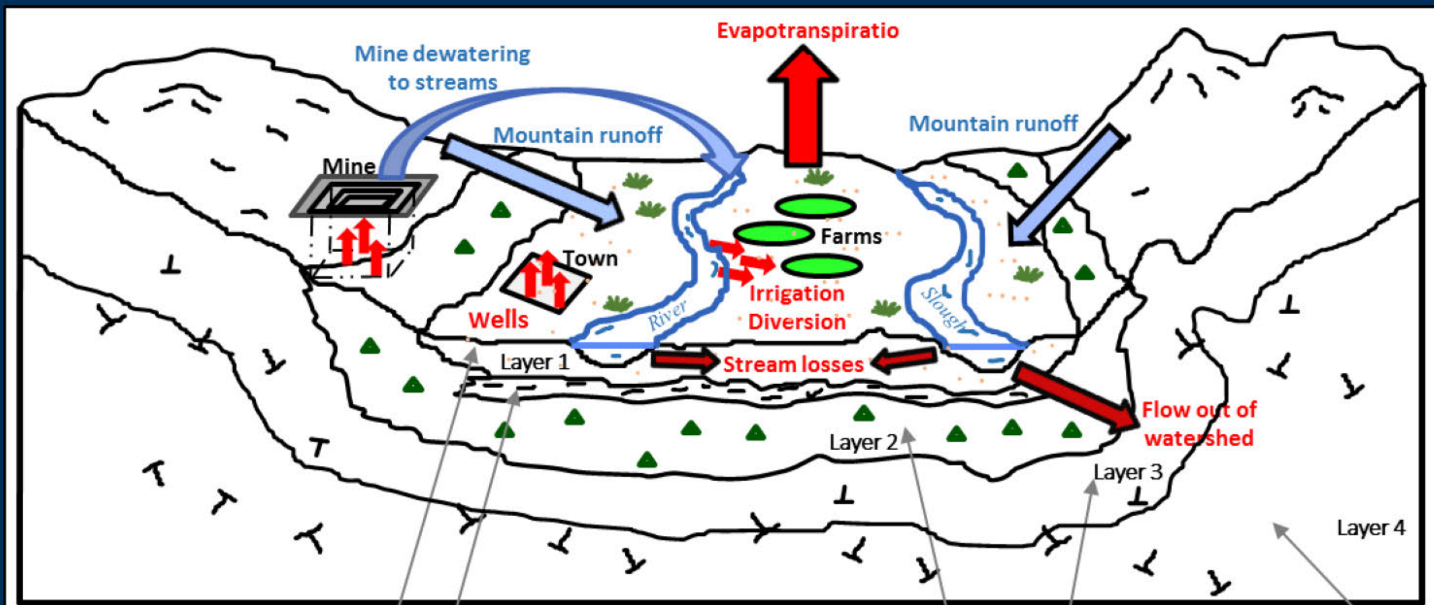
Model Steps – Conceptual Model

Describing the groundwater flow system:



Layer 1: Floodplain deposits
Playa, Valley Floor, Alluvial Slope, Fluvial deposits
Thickness 30 to 75 ft.

Confining layer (clay)
Below layer 1
Thickness 10 to 50 ft.

Layer 2: Older basin fill
Tertiary fine-grained semi-consolidated sediments
Thickness 600 ft.

Layer 3: Upper hard rock
Clastic sedimentary, carbonate and mixture, intrusive, metamorphic, clastic sandstones
Thickness 1200 ft.

Layer 4: Lower hard rock
Clastic sedimentary, carbonate and mixture, intrusive, metamorphic, clastic sandstones
Thickness variable ~1800 ft.

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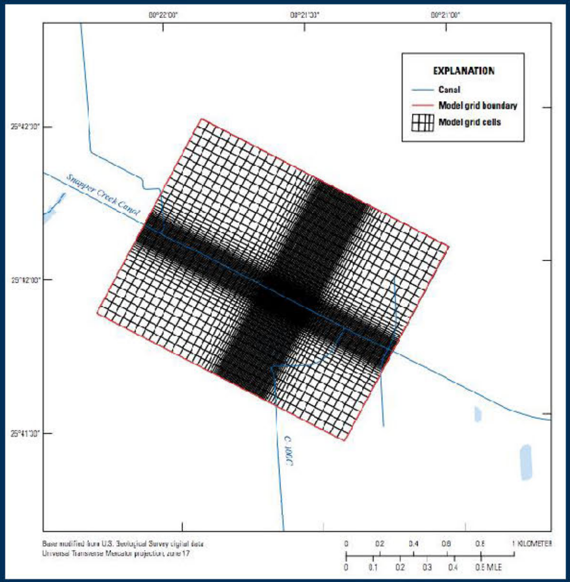
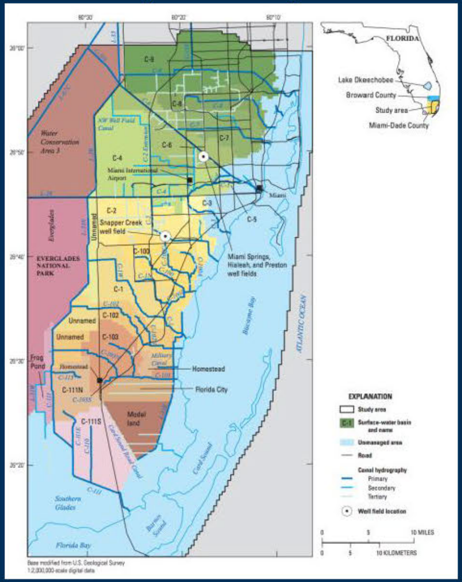
Model Steps – Mathematical Model

Boundary Conditions and Initial Conditions

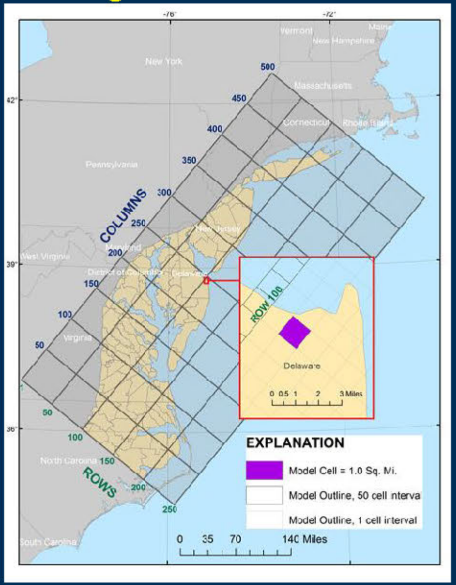
site



county/subregional



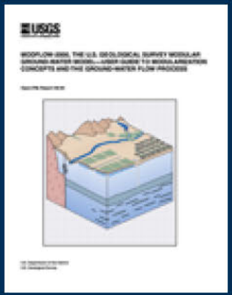
regional/state



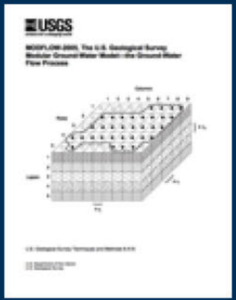
1984

1988

1996



2000



2005

6th Version (in review)

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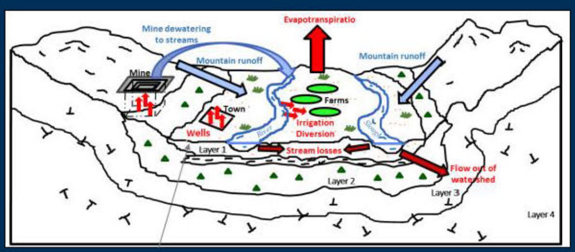
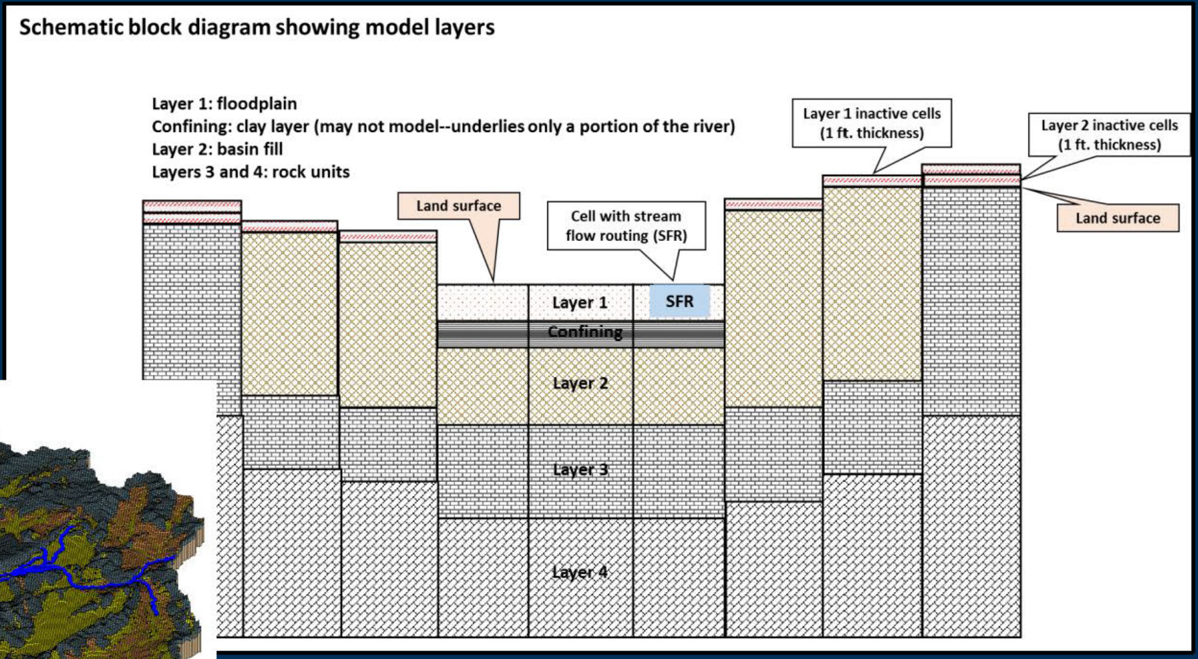
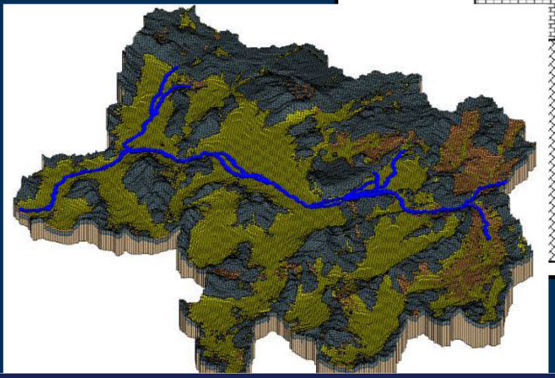
Model Steps – Model Design

Moving conceptual model into numerical groundwater flow model (Create grid, set boundaries, define aquifer parameters and hydrologic stresses, and for transient models – initial conditions and time steps







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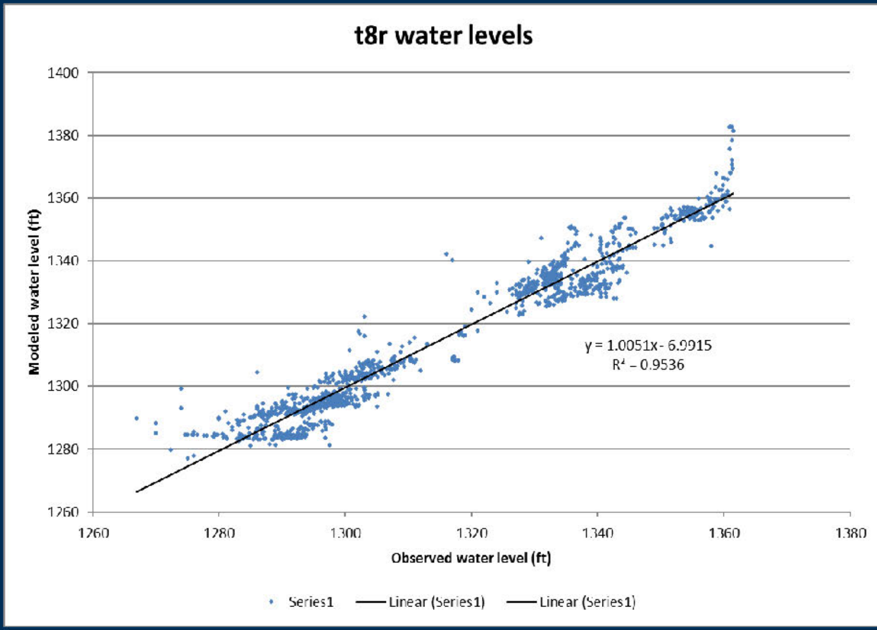
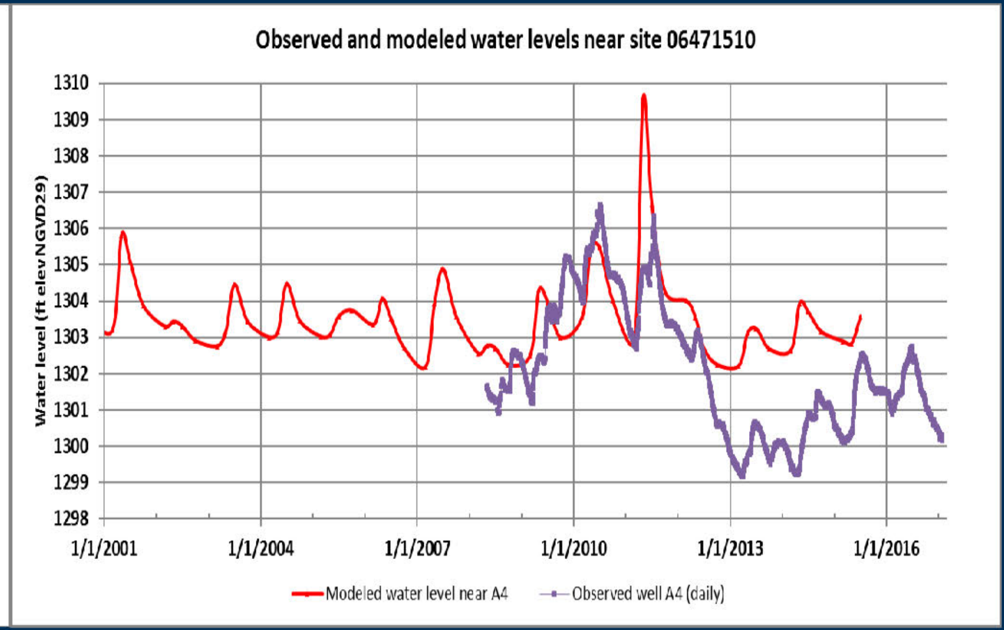
Model Steps – Calibration

Most important step in the modeling process. History matching and selecting calibration targets helps to fit model result to field observations.





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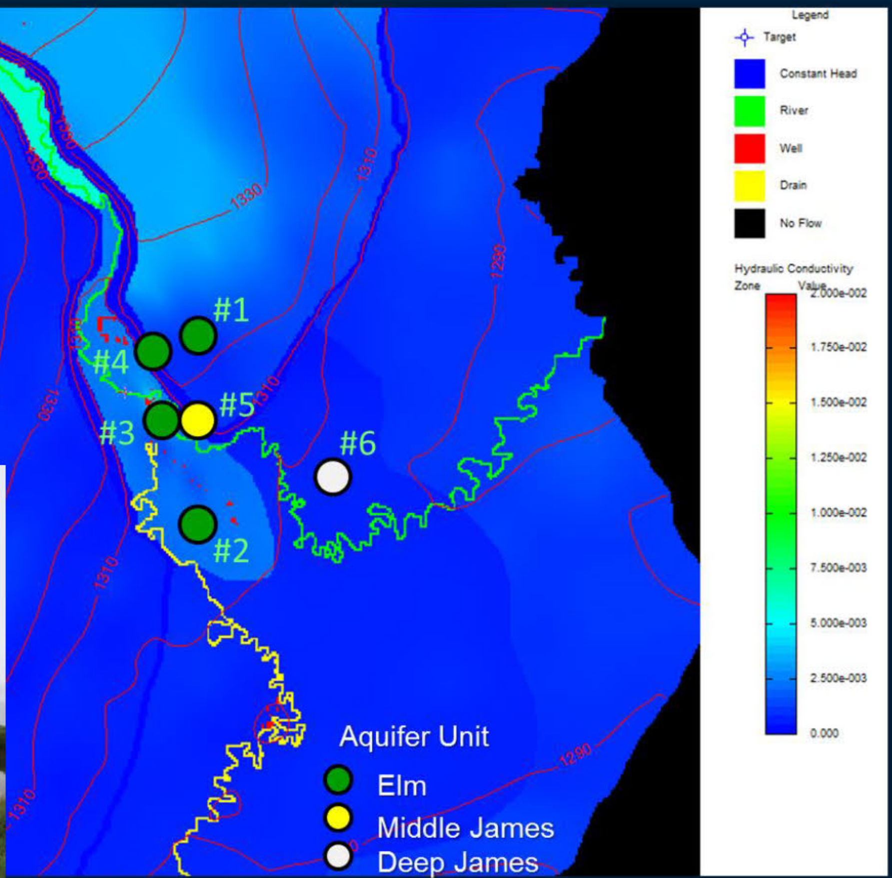
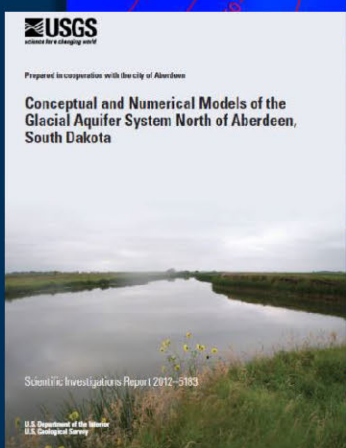
Model Steps – Simulations, Uncertainty, and Publication

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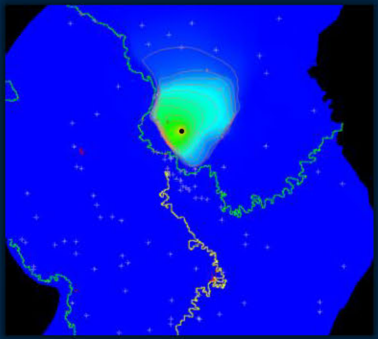
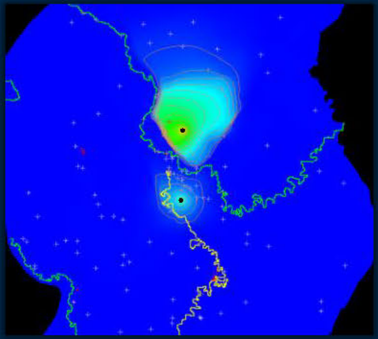
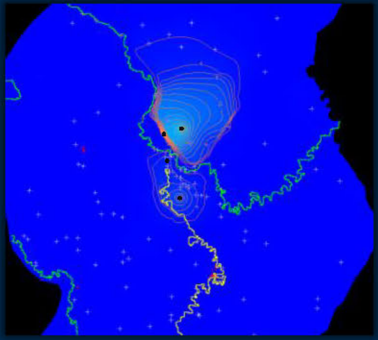
science for a changing world
Prepared in cooperation with the city of Aberdeen
Conceptual and Numerical Models of the Glacial Aquifer System North of Aberdeen, South Dakota
Scientific Investigations Report 2012–5183
U.S. Department of the Interior
U.S. Geological Survey







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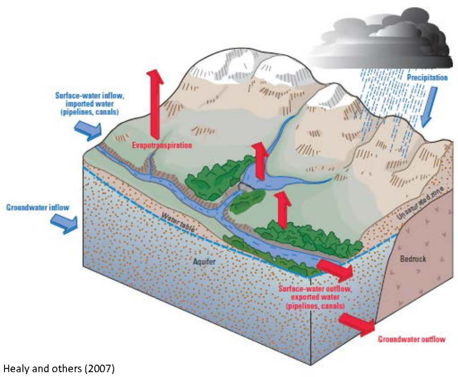
Benefit

- Groundwater Budget
- Subsidence
- Solute Transport
- Contamination
- Potential Assessment

Account for water with a "budget"



Water budgets: a unifying theme for assessment of groundwater availability

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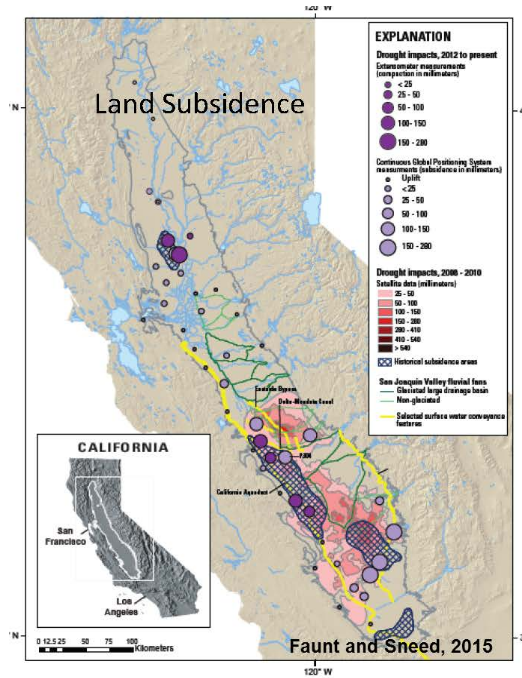

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